GEFÖRDERT VOM

Bundesministerium
für Bildung
und Forschung

FSP 101
ATLAS

# Update on Template Method for $m_{top}$ determination in the l+jets channel

**preliminary results from top-mixing exercise**


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# Introduction

The idea is to apply the template method to measure mtop in the TopMixing samples.

This is a good exercise in order to prepare ourselves to real data (to come later this year)

In this talk focus is on TopMixing Exercise v1 (i.e. top, W+jets and single top only).

In order to cope with data streaming, electron and muon channel are maintained separated.

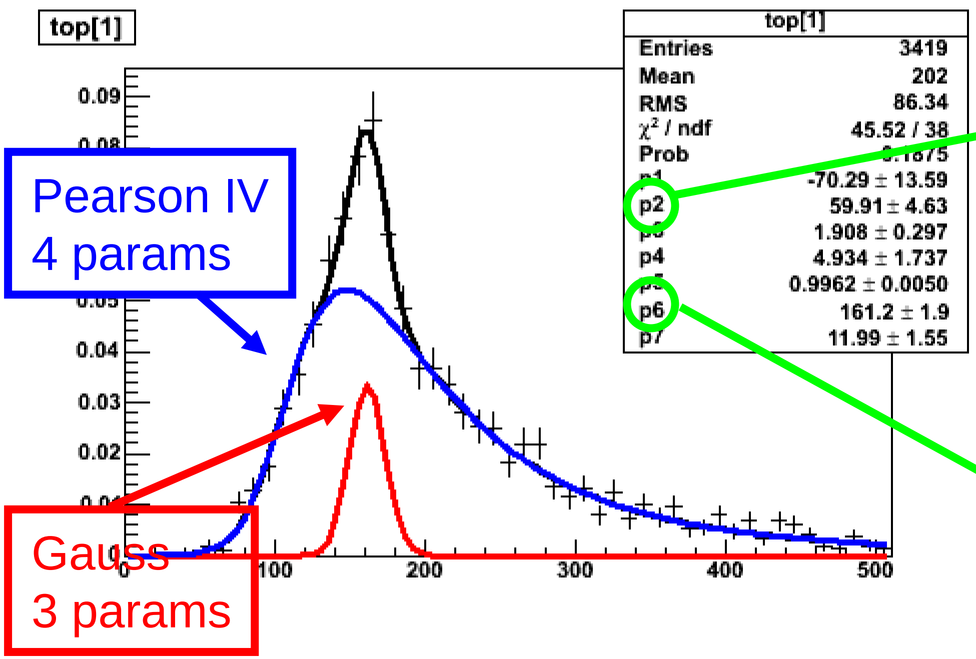
*Standard event selection:*
(exp W+jet fraction ~ 1/3)

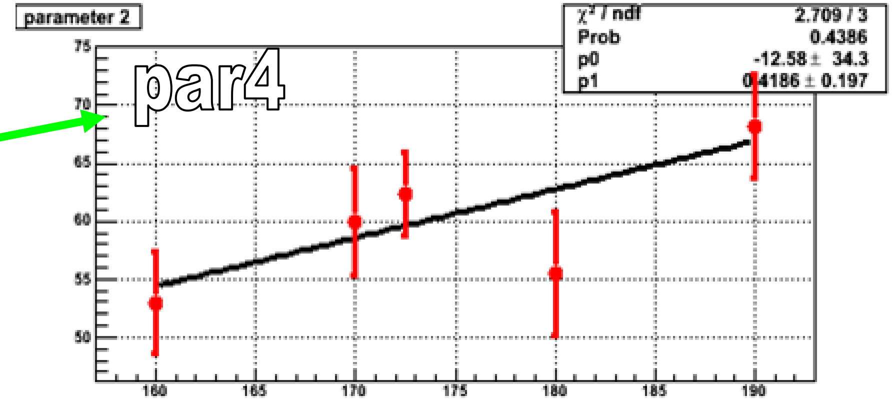
- Trigger fired (e20_loose/ mu20)
- Only one lepton with $p_T$> 20 according to the stream
- *At least 4 jets with $p_T$>20, 3 with $p_T$>40*
- HEC Q veto for jets above 10 GeV
- No missing ET cut

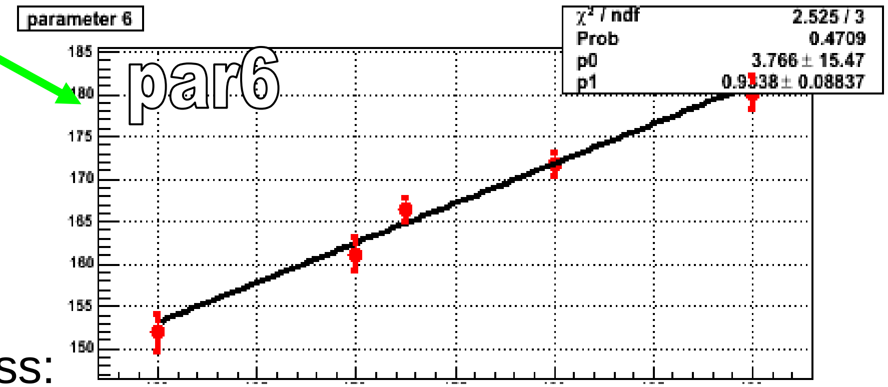
*Loose event selection* (for matrix-method)
(exp W+jet fraction ~3/4)

- Trigger fired (e20_loose/ mu20)
- Only one lepton with pt> 20according to the stream
- *At least 3 jets with pt>20*
- HEC Q veto for jets above 10 GeV
- No missing ET cut

# Top mass templates




We used one Pearson IV* + Gaus parameterization per each generated top mass:

7 parameters x each ttbar mass sample

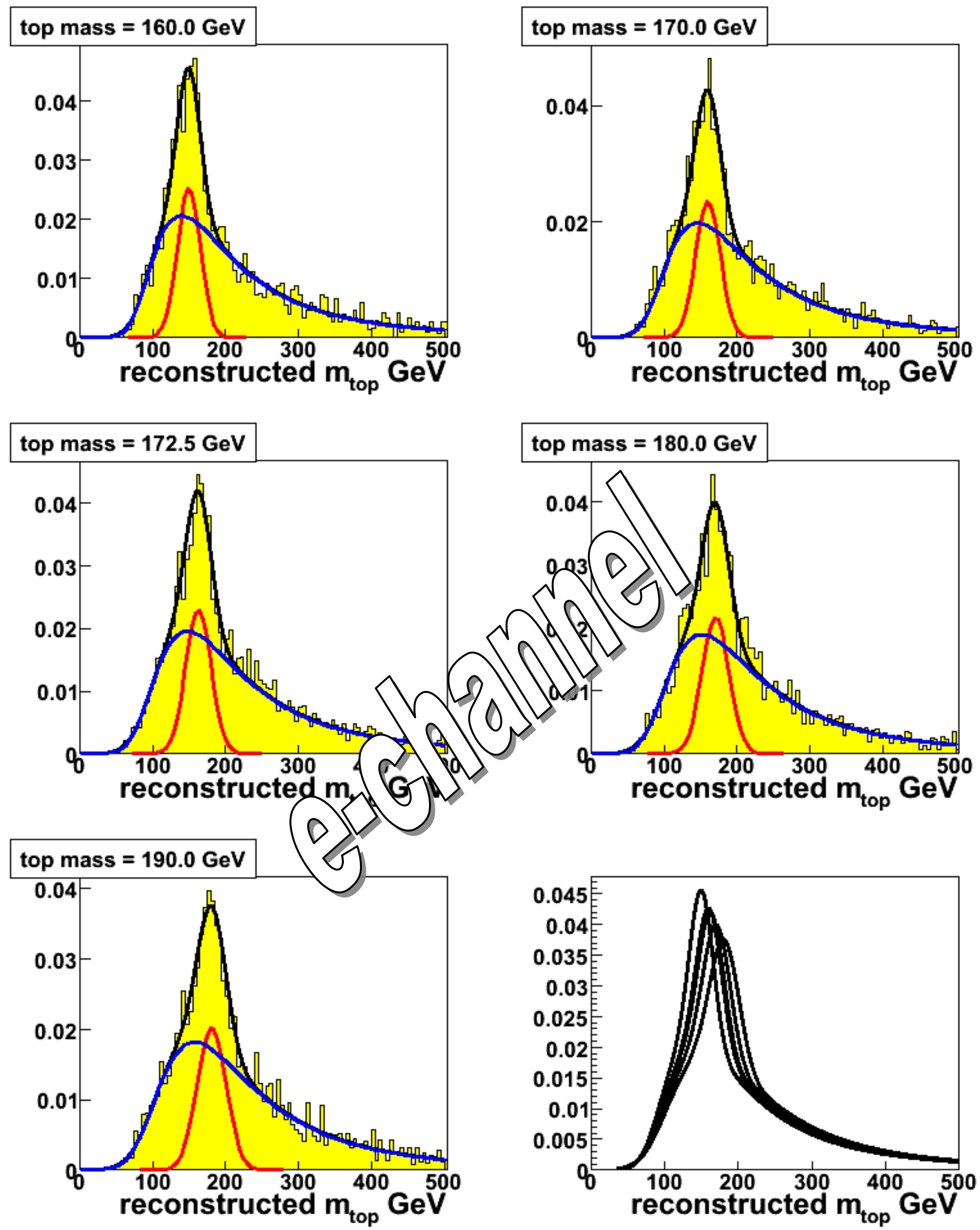
7x2 parameters

however parameters are linearly dependent on the top mass used in the sample generation (on the right plots, the value of two fit parameters vs $m_{top}$ is shown, see backup for further details).

*Phys. Rev. D **75**, 111103(R) (2007)

Note: no trigger is applied for a68 sample series

# Fitting all top mass templates together




- We can fit all top mass templates for signal together by requiring that all parameters ($p_i$) depend linearly on $m_{top}$:

$$p_i = \alpha_i + \beta_i \cdot m_{top}$$

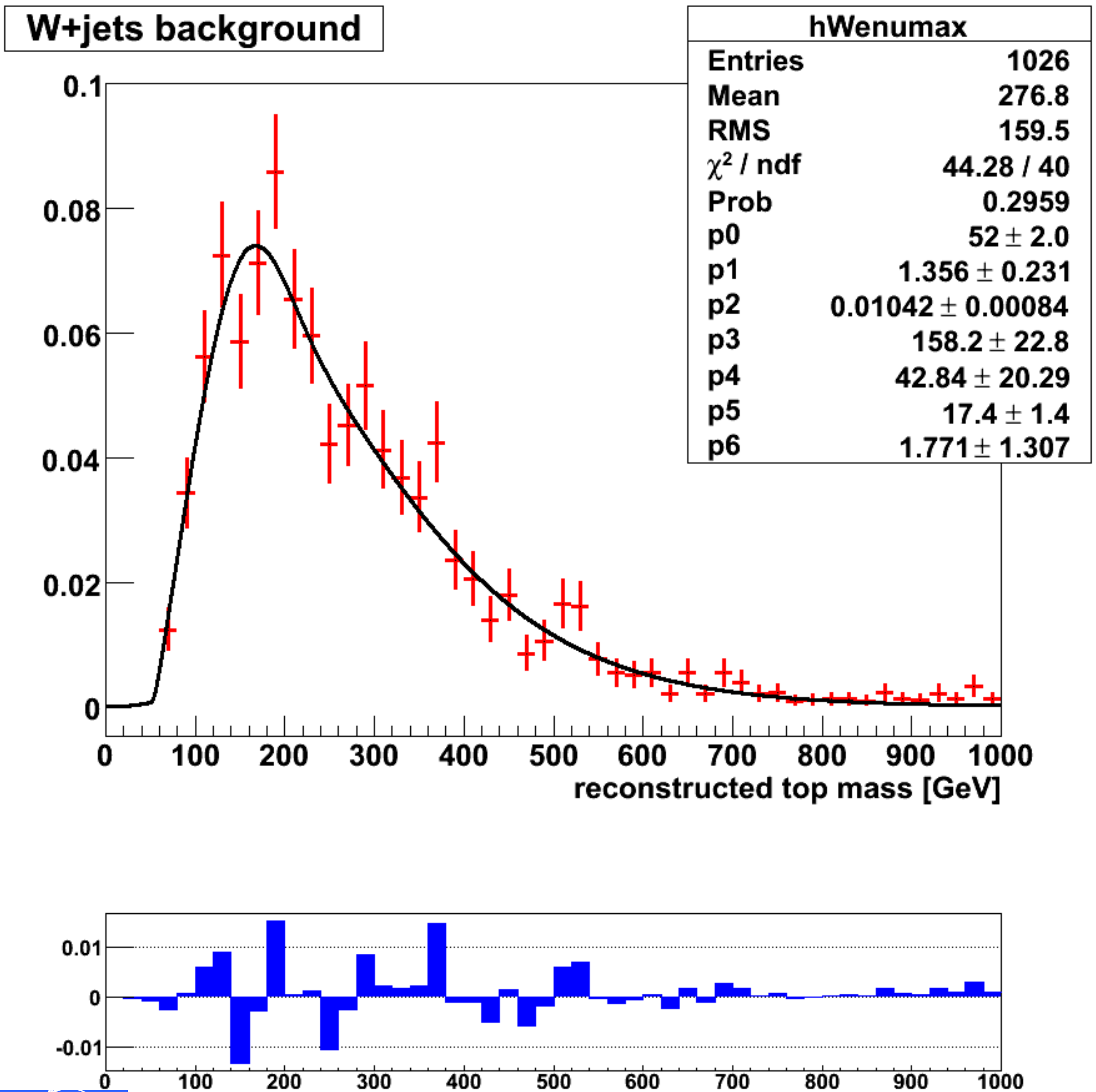
- The fits returns $\alpha_i$ and $\beta_i$ *(14 parameters in total)*

  Fit result:

  $\chi^2$/ndof = 1.24 for e (1.20 for $\mu$ )

- In this way we obtain a continuous function which interpolates between templates and can be used in an un-binned likelihood fit

# Background $m_{top}$-independent




**e-channel**

Parameterization of the background w/o contributions from single top and all-hadronic ttbar

Gamma + Gaus for parameterization:
7 parameters,
$m_{top}$ – independent by construction.

# The fit : un-binned likelihood terms

$$L(m_{top}) = L_{shape}(m_{top}) \times L_{N_s+N_b} \times L_{bkg}$$

shape

$$L_{shape}(m_{top}) = \prod_{i=1}^{N} \frac{N_s \cdot P_{sig}(m_{rec}^i \mid m_{top}) + N_b \cdot P_{bkg}(m_{rec}^i)}{N_s + N_b}$$

normalization

$$L_{N_s+N_b} = \frac{e^{-(N_s+N_b)} \cdot (N_s + N_b)^N}{N!}$$

background

$$L_{bkg} = e^{-\frac{(N_b^{\exp} - N_b)^2}{2\sigma^2_{N_b^{\exp}}}}$$

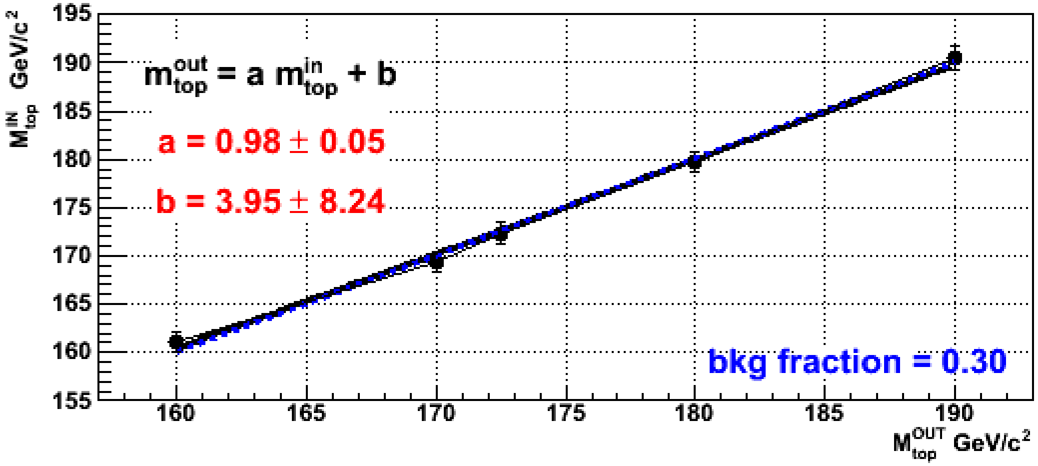
| process | e-channel Evt/pb | μ-channel Evt/pb |
|---|---|---|
| Signal | 14.1 | 18.1 |
| Single top | 0.86 | 0.99 |
| W+jets | 6.0 | 8.7 |
| *BKG fraction (no stop)* | *0.3* | *0.33* |

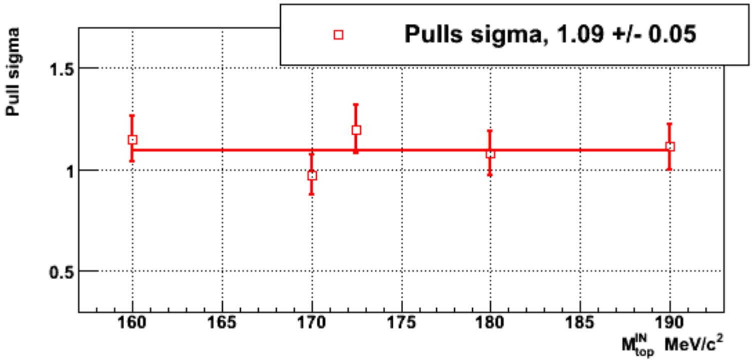
Minimize –log(L) with respect to $N_s$, $N_b$, and $m_{top}$

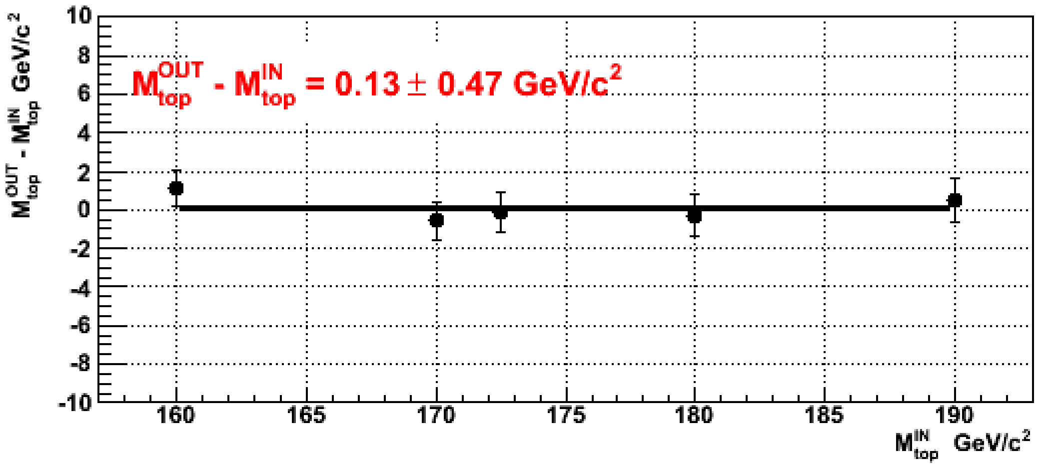
$P_{sig}$ and $P_{bkg}$ are the normalized probability density functions determined from template fits

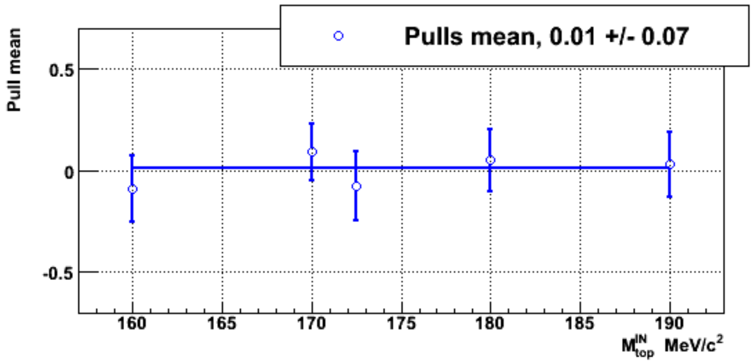
# Pseudo-experiment results @ 10/pb

## e-channel



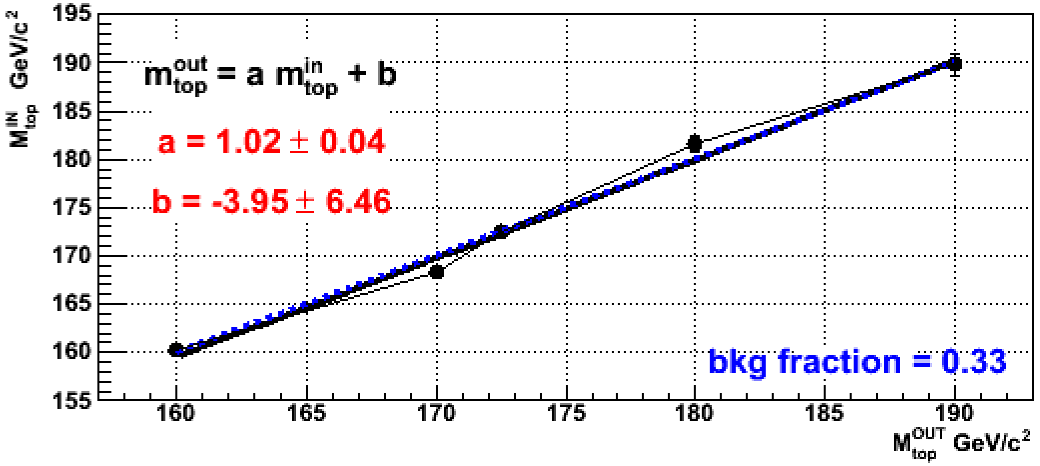



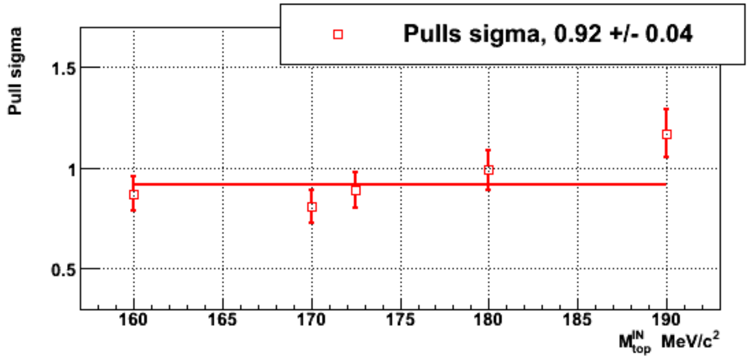



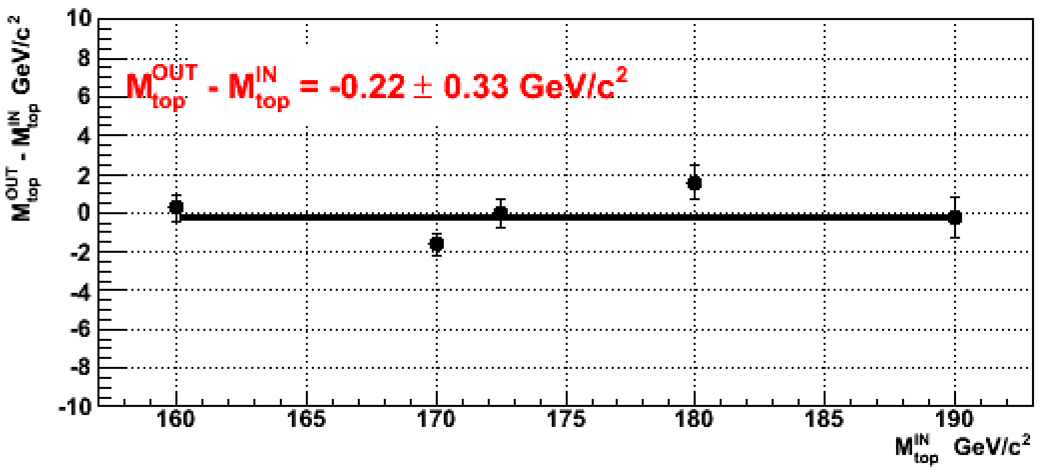



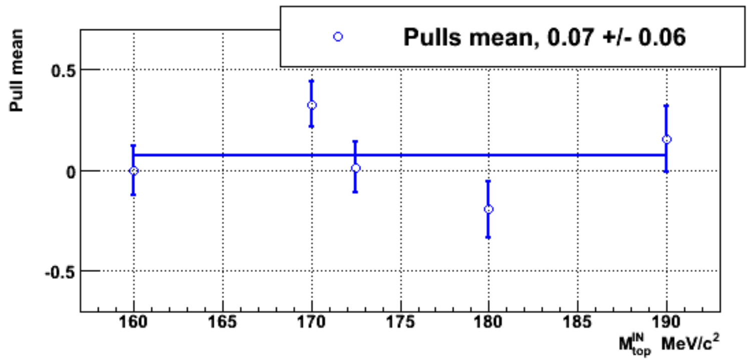
# Pseudo-experiment results @ 10/pb

## mu-channel



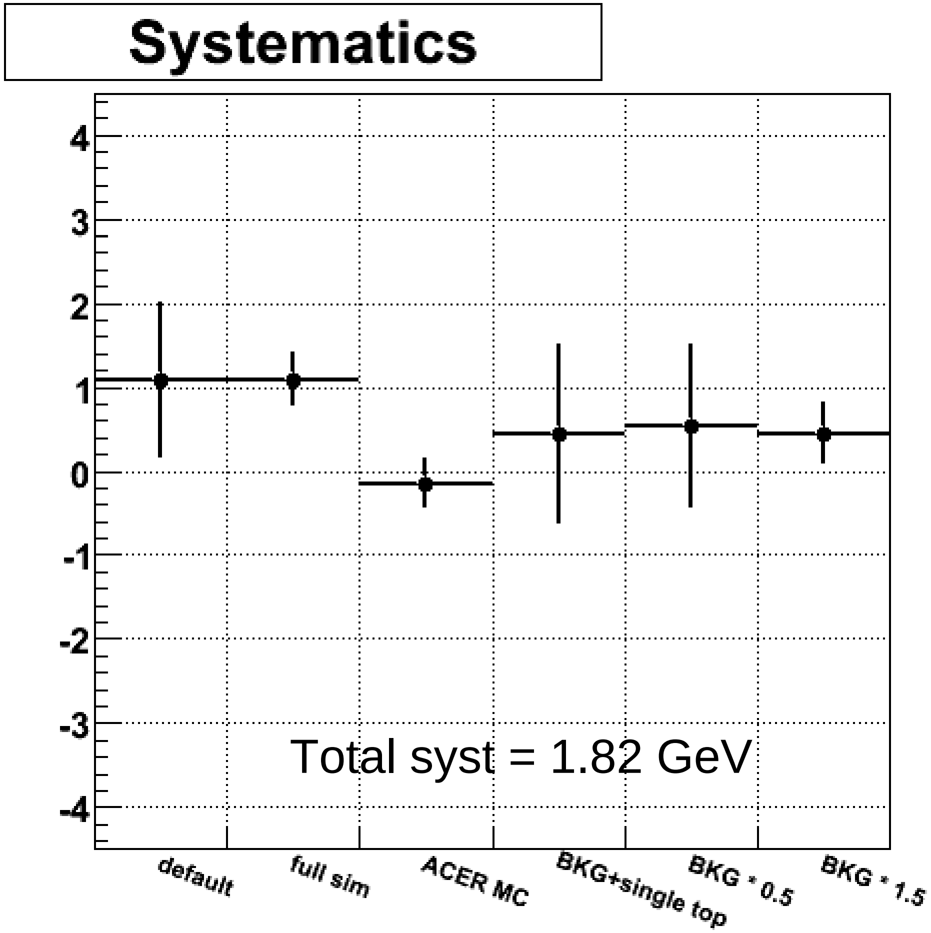



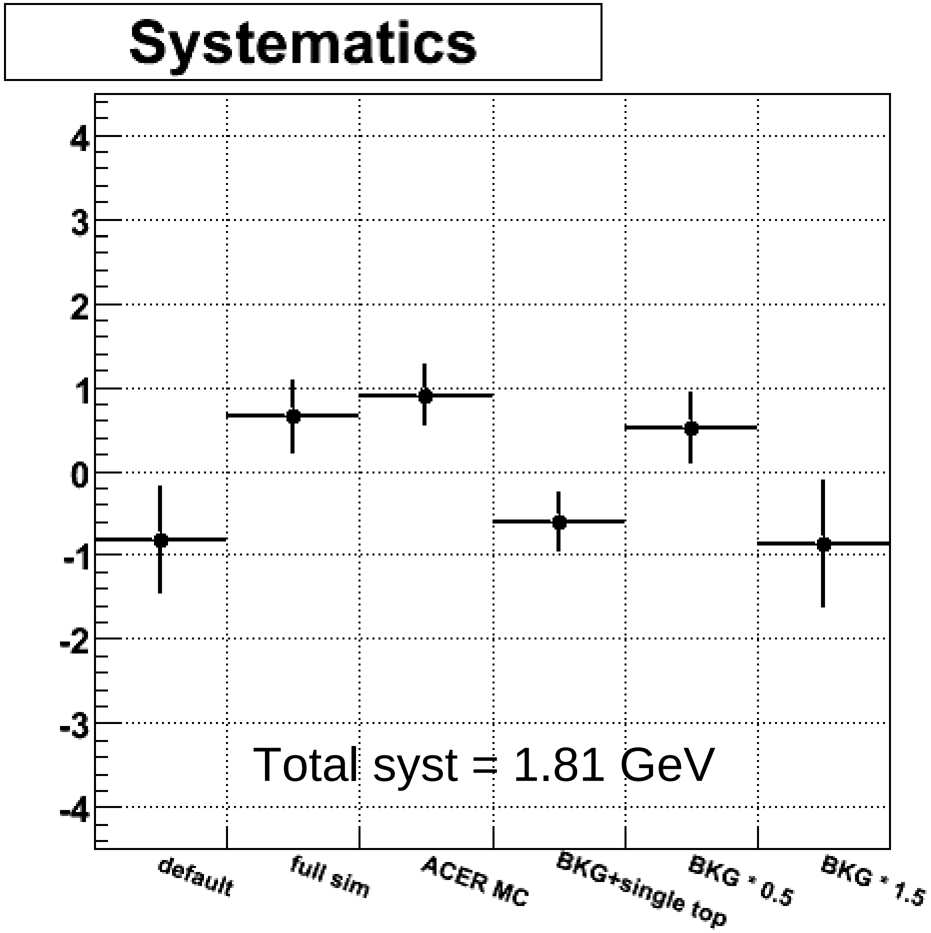



# Some systs

## e-channel

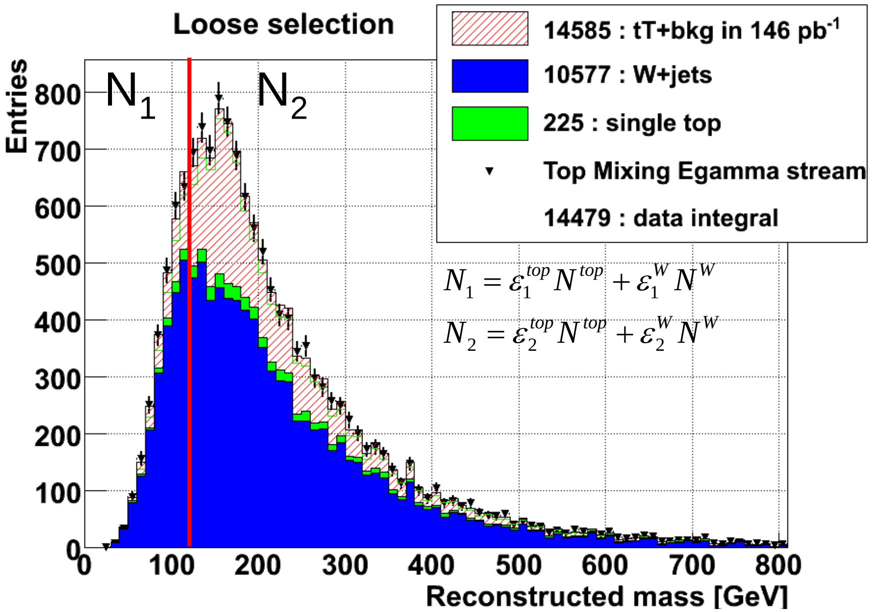



## mu-channel




Note: syst are evaluated running 5 pe @ 150/pb.

# Top mixing sample results: e-channel

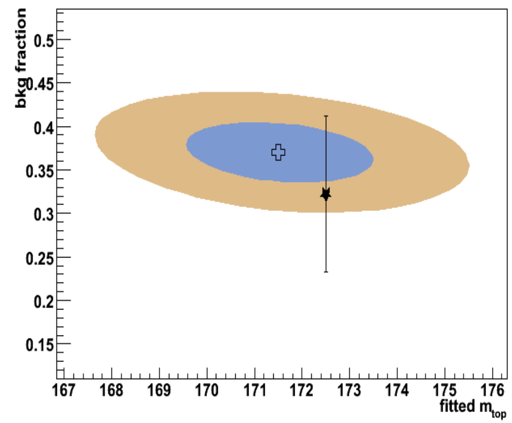


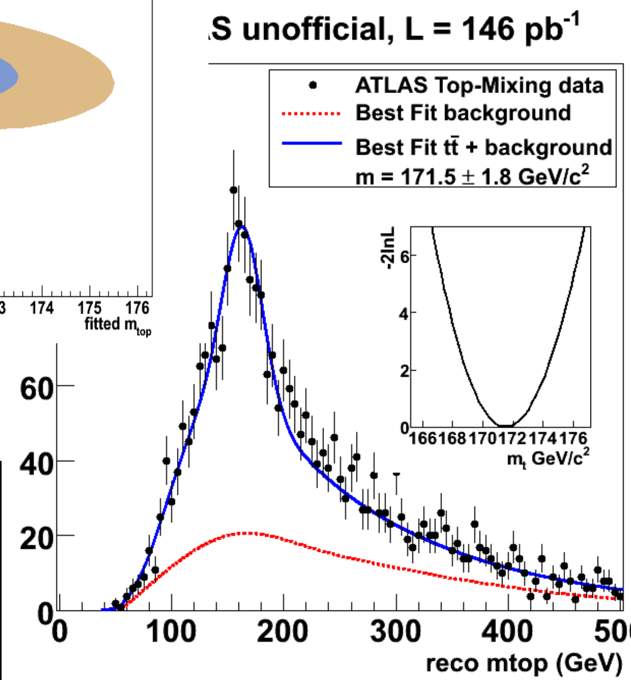

Applied matrix-method to W+jets and top to determine their normalization in "data"

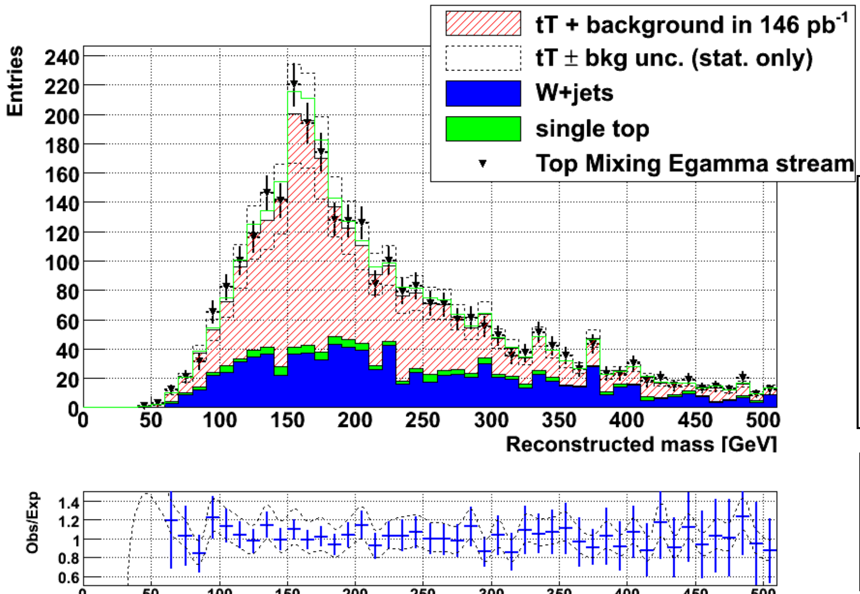
$\#W_{top\ mix} = (1.13 \pm 0.09) \times \#W_{SM}$

$\#Tt_{top\ mix} = (0.89 \pm 0.13) \times \#tT_{SM}$

#s-top is fixed to SM expectation



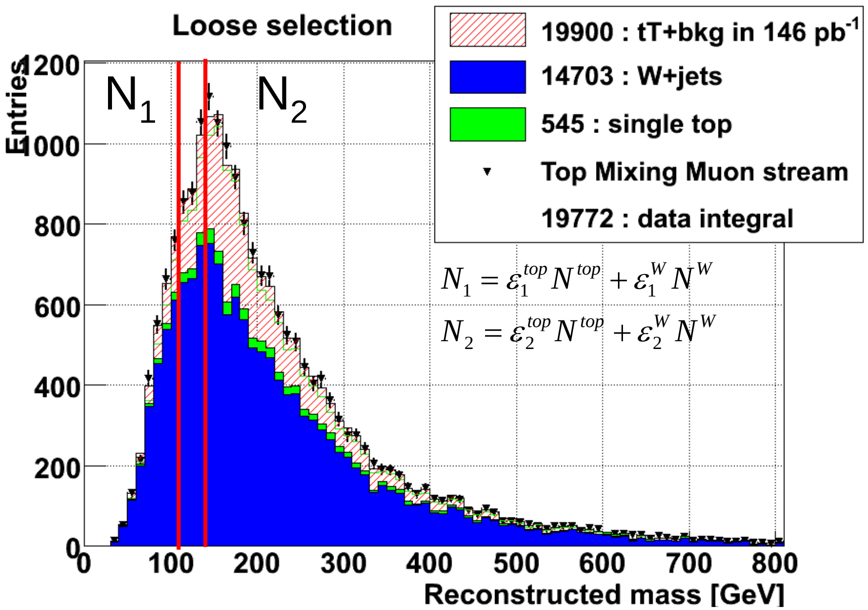




Applied TMT method, bkg constr. to $\#W_{topmix} \pm 30\%$

$m_{top} = 171.5 \pm 1.8\ (stat) \pm 1.8\ (syst)$ GeV
$= 171.5 \pm 2.6$ GeV

# Top mixing sample results: $\mu$-channel

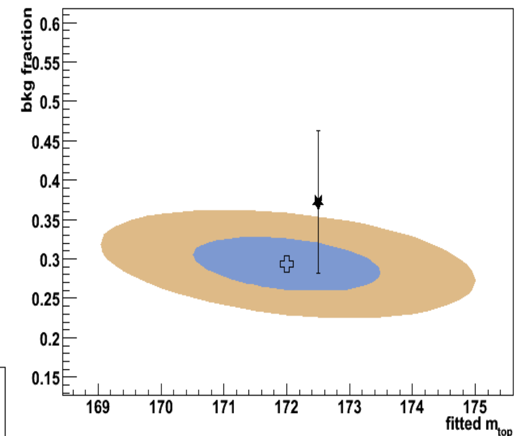


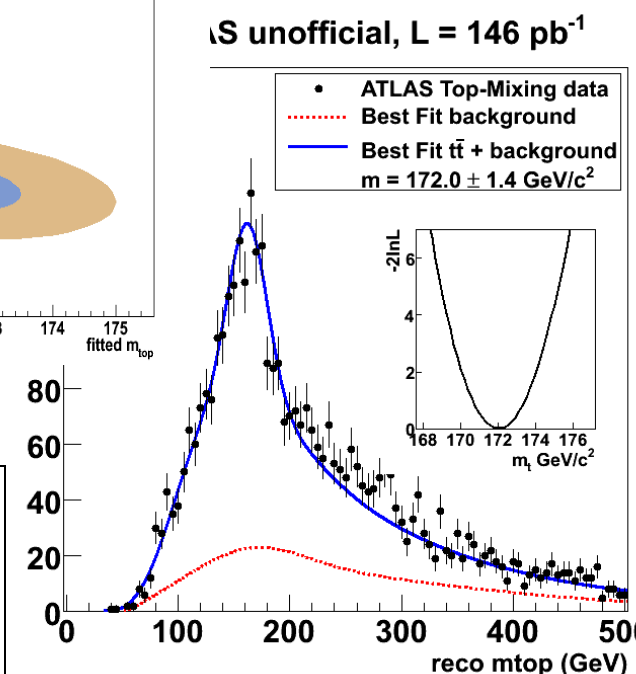

Applied matrix-method to W+jets and top to determine their normalization in "data"

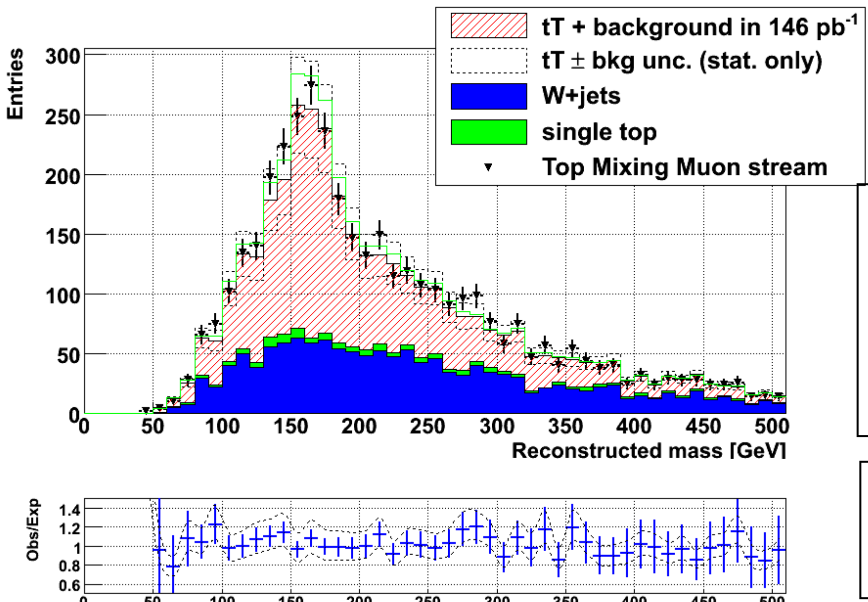
$\#W_{top\ mix} = (1.15 \pm 0.08) \times \#W_{SM}$

$\#Tt_{top\ mix} = (0.84 \pm 0.16) \times \#tT_{SM}$

#s-top is fixed to SM expectation




Applied TMT method, bkg constr. to $\#W_{topmix} \pm 30\%$

$m_{top} = 172.0 \pm 1.4\ (stat) \pm 1.8\ (syst)$ GeV
$= 172.0 \pm 2.3$ GeV

# Conclusions/plans

- A machinery to determine $m_{top}$ using un-binned-likelihood fits on top mixing samples (v1) has been setup

- Results are well in agreement with the expectations

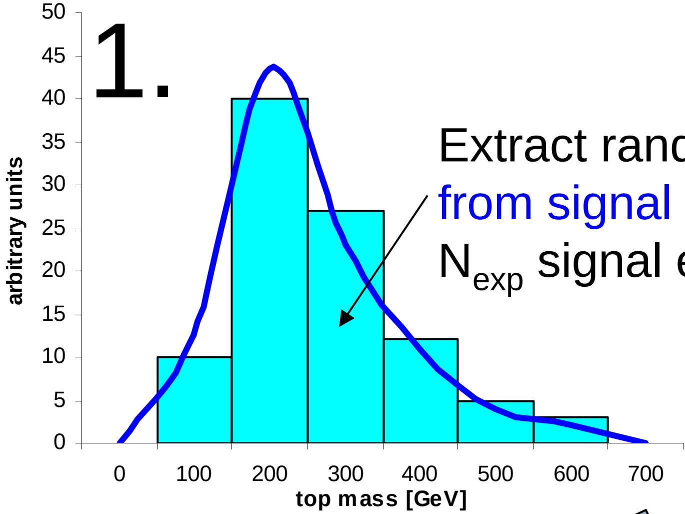
- For the next top mix sample exercise:
  - refine signal/bkg parameterization
  - refine our matrix-method-based background normalization to account also for Z+jets.

- Apart from Top mixing exercises, we also need to see whether with the matrix-method we could also determine the QCD background (which may not be negligible), the current idea could be to use a two step procedure: top+W/Z vs QCD, and then top vs W/Z after QCD subtraction.

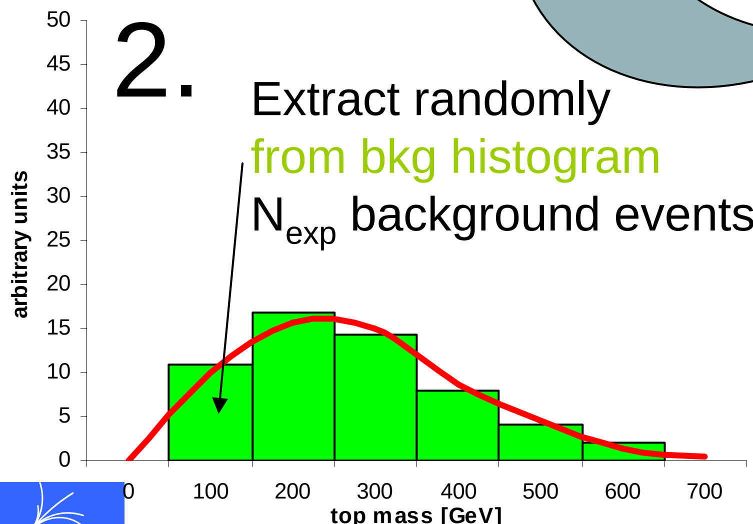
# - backup slides -

# Pseudo-experiments (cartoon)

for a given generated top quark mass and $L_{int}$ (i.e. $m_{top}$ = 172.5 GeV, $L_{int}$ = $10pb^{-1}$):



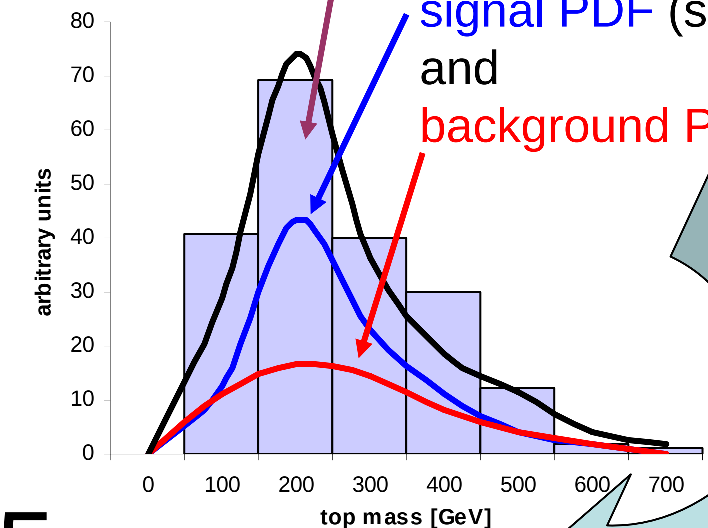

1. Extract randomly from signal histogram $N_{exp}$ signal events




2. Extract randomly from bkg histogram $N_{exp}$ background events

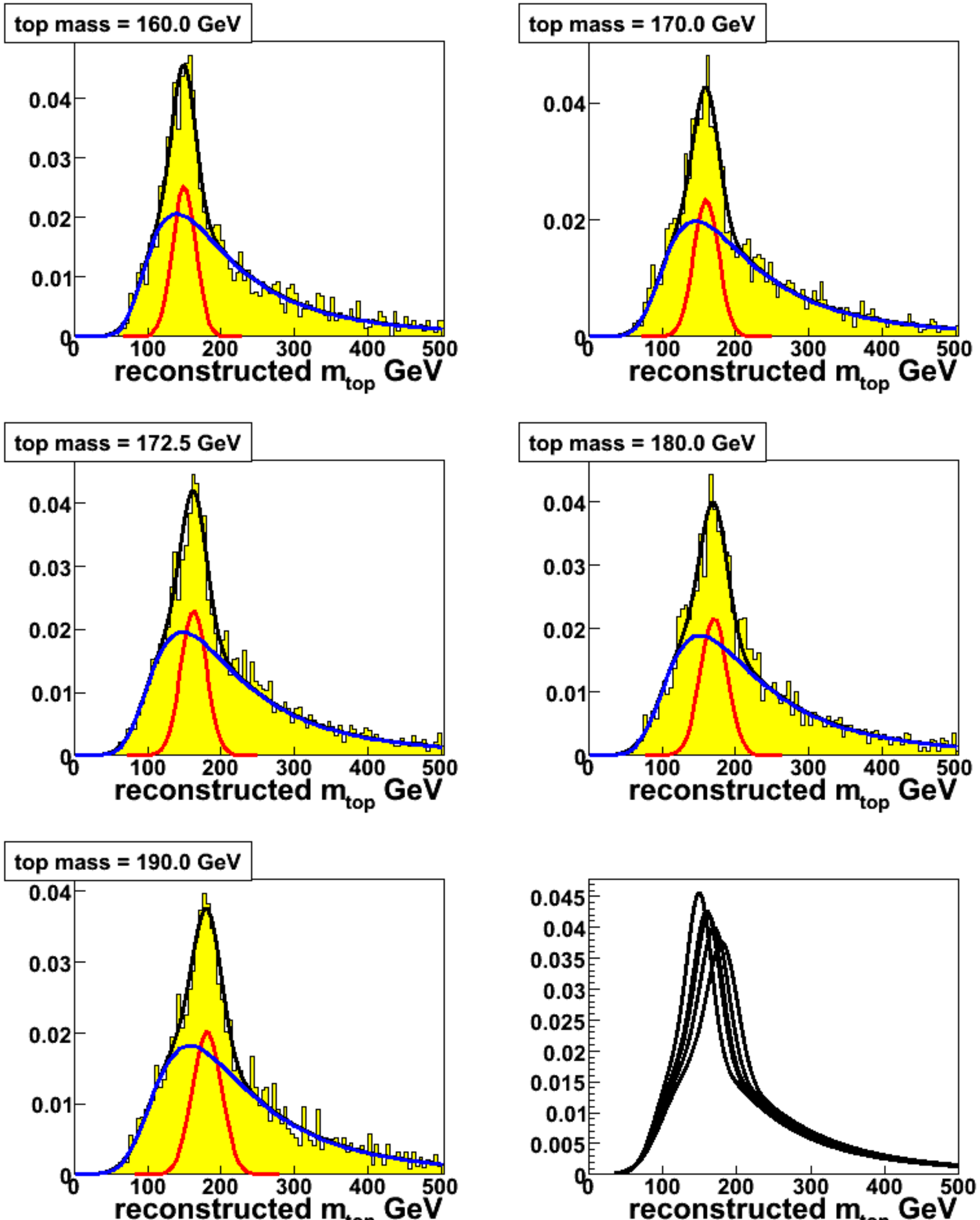
3. Generate the pseudo-data sample as the sum of background and signal expectations.

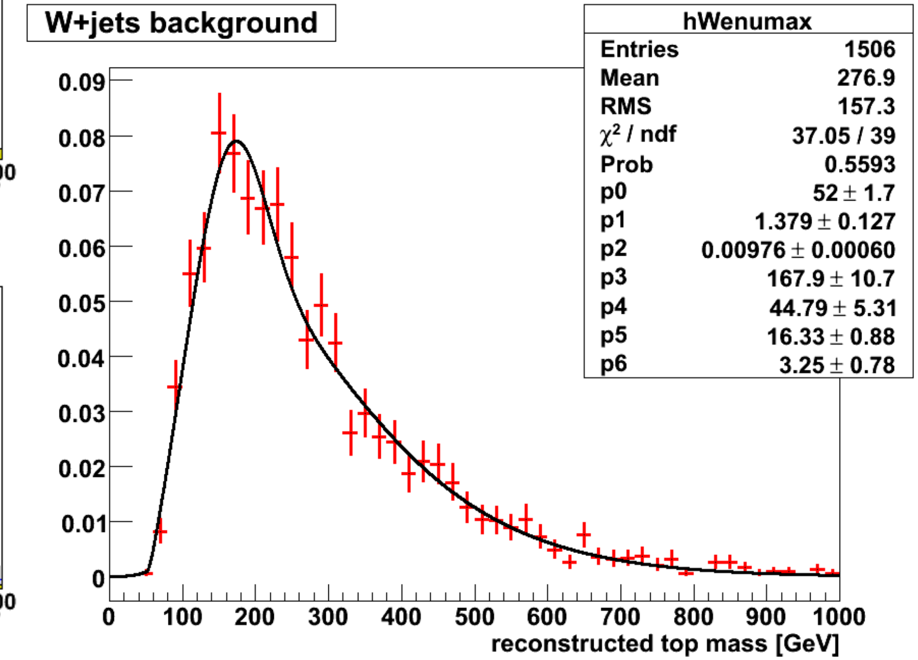
4. Fit pseudo-data to the sum of the signal PDF (shape) and background PDF.

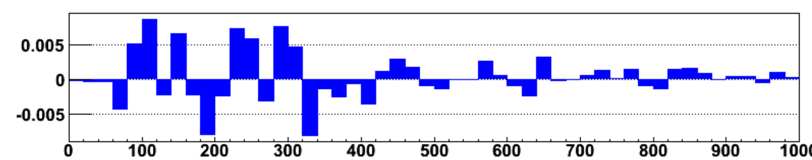



5. Repeat the procedure

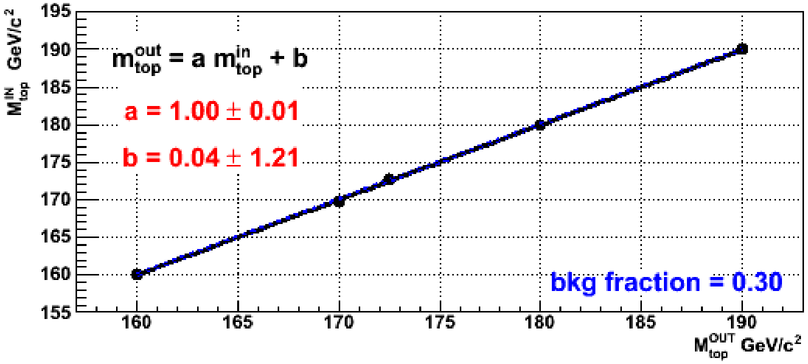
# PDFs in the μ-channel

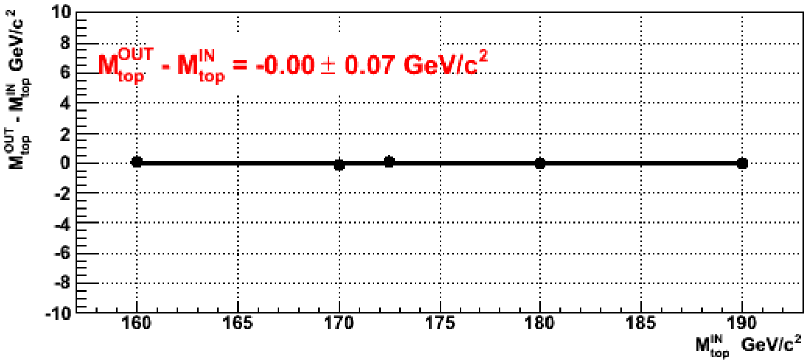


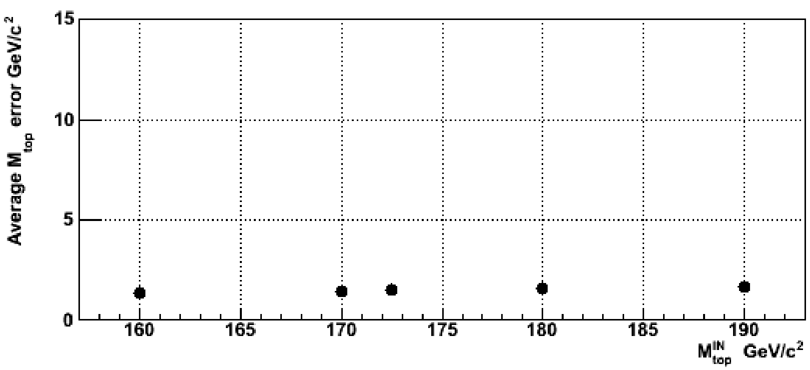



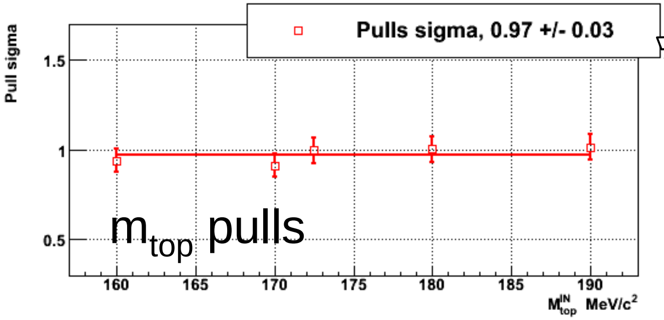



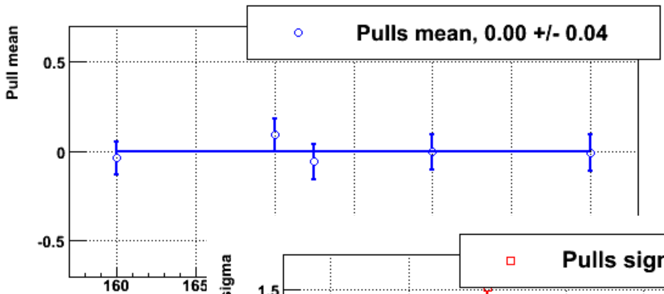
# Procedure sanity-checks using shapes

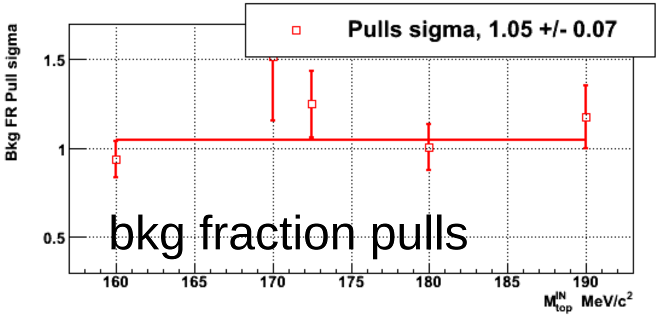


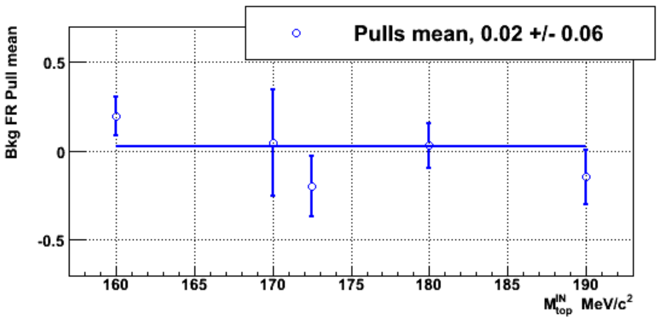




e-channel
100 pe @ 150/pb
no bkg contraint

# matrix method (D0)

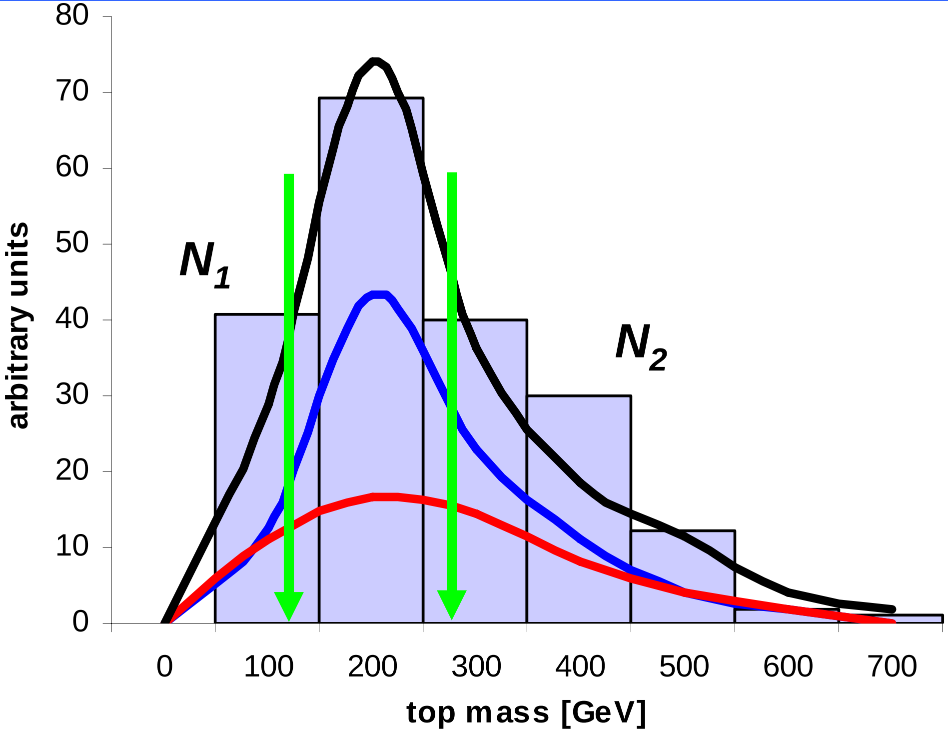
Matrix method is used in D0 to get the normalization of QCD events.

$$N_1 = \varepsilon_1^{top} N^{top} + \varepsilon_1^W N^W$$

$$N_2 = \varepsilon_2^{top} N^{top} + \varepsilon_2^W N^W$$

$$N^{top} = \frac{N_2 - \frac{\varepsilon_2^W}{\varepsilon_1^W} N_1}{\varepsilon_2^{top} - \frac{\varepsilon_2^W}{\varepsilon_1^W} \varepsilon_1^{top}}$$

$$N^W = \frac{N_1 - N^{top} \varepsilon_1^{top}}{\varepsilon_1^W}$$




By knowing $\varepsilon_{1,2}^{top}$ and $\varepsilon_{1,2}^{W}$ from MC and the number of observed events in the the "data" regions 1 and 2,
we can calculate the number of top and W+jets events we had before kin sel.
Applying then the kin sel efficiency we can get the normalization of top and W in the observed distribution

# matrix method: too simple to be true?

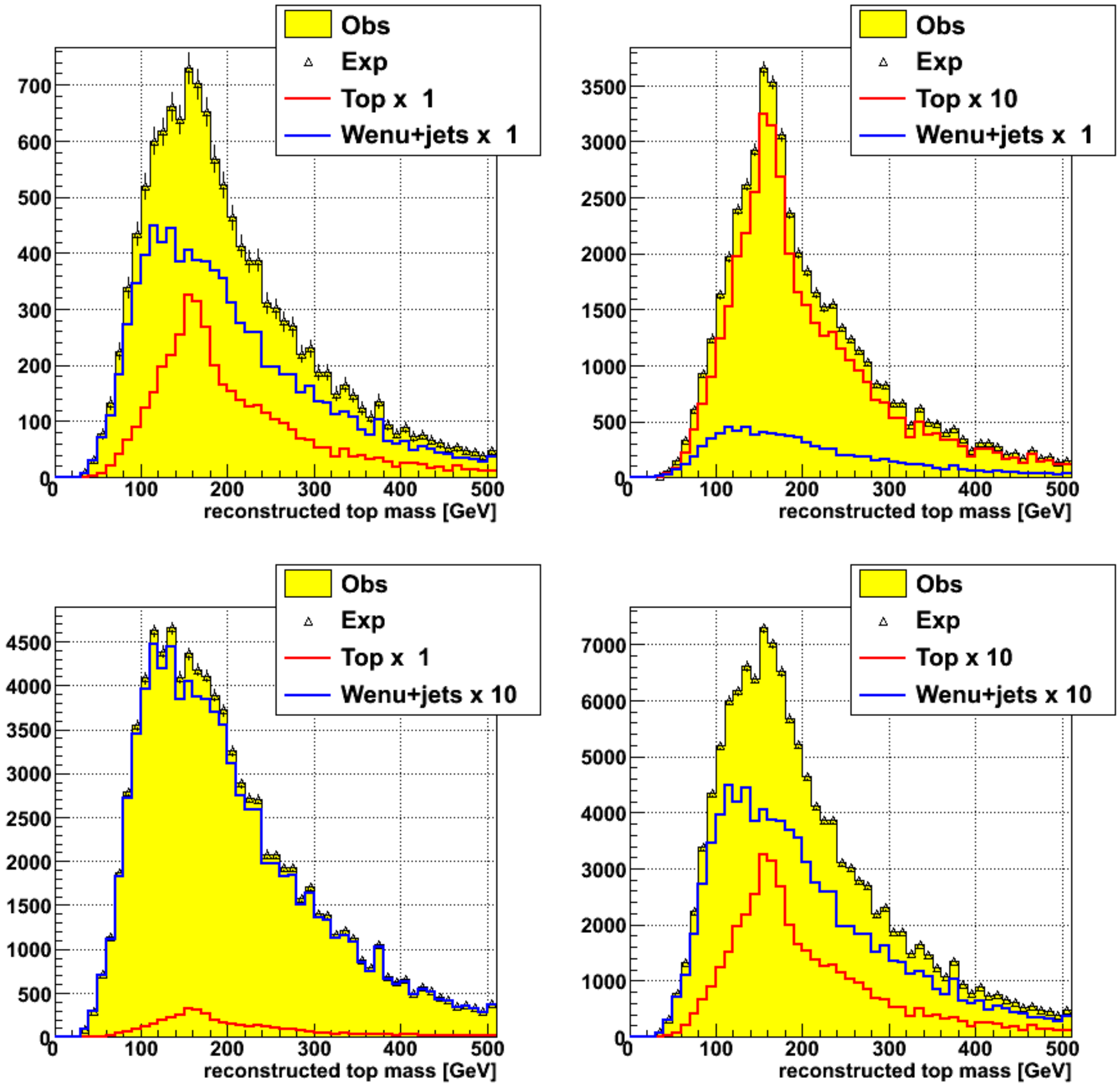
pseudo-exp with he following samples:

- tT Acer MC
- W+jets bkg

From the expected number of events in 146 pb-1 Using the SM x-sec, pseudo data were constructed varying the top and w+jet contribution (from 0.1 to 10 times the expectations)

$\varepsilon_{1,2}^{top}$ and $\varepsilon_{1,2}^{W}$ are derived once from the corresponding MC samples.

We then applied the matrix method to normalize Top and W+jets contribution



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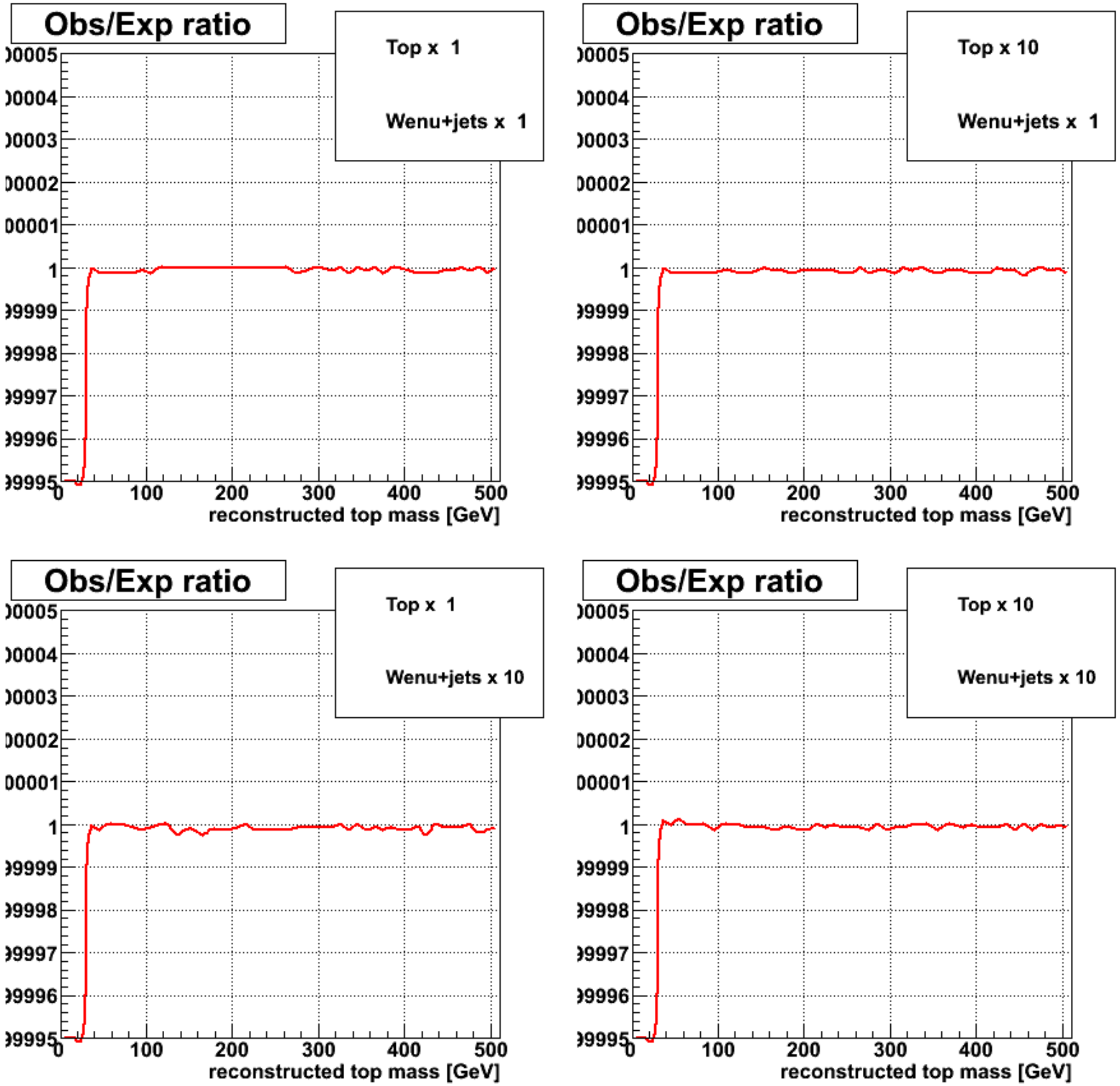

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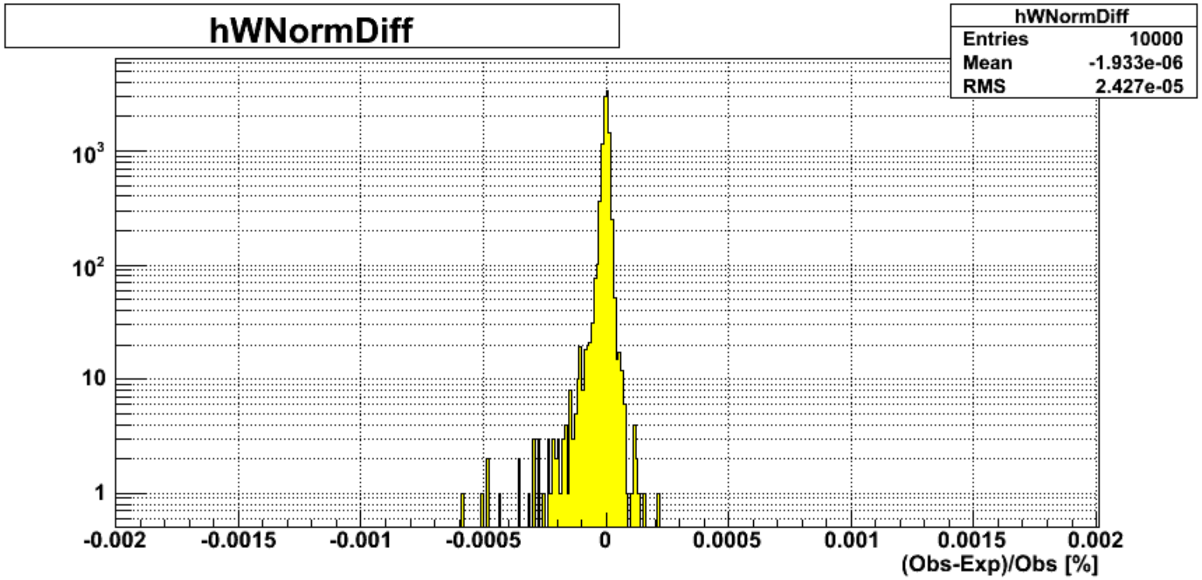


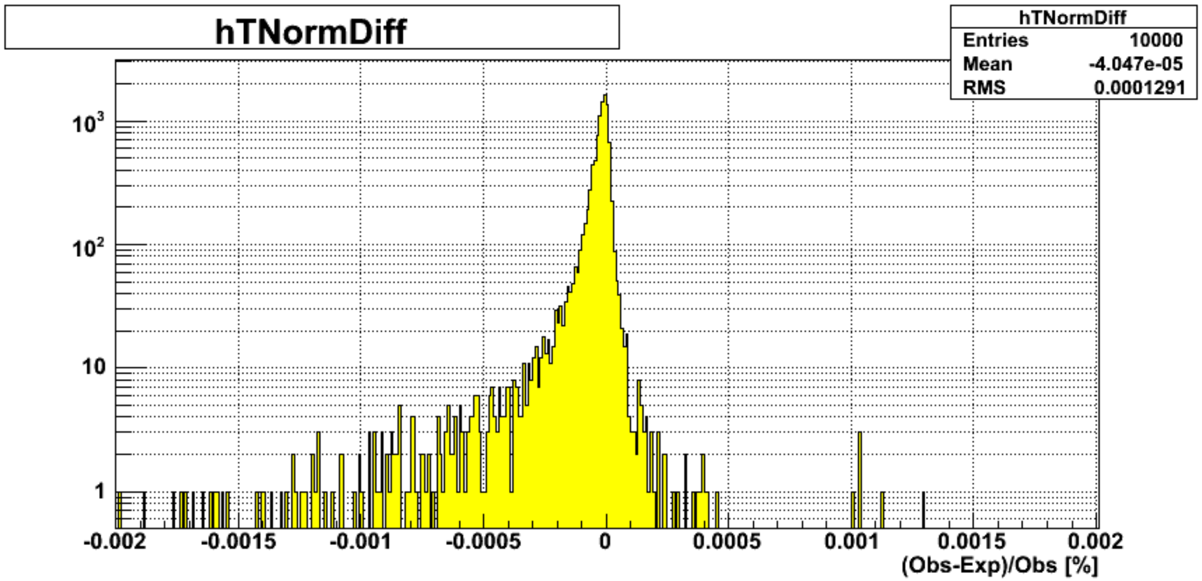

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